2013

Firm Strategy and the Internet in U.S. Commercial Banking

K. H. GOH

Robert J. Kauffman
Singapore Management University, rkauffman@smu.edu.sg

DOI: https://doi.org/10.2753/MIS0742-1222300201

FIRM STRATEGY AND THE INTERNET IN AMERICAN COMMERCIAL BANKING

Kim Huat Goh
Nanyang Business School
Nanyang Technological University
akhgoh@ntu.edu.sg

Robert J. Kauffman
School of Information Systems
Singapore Management University
Email: rkauffman@smu.edu.sg

Last revised: April 21, 2013

ABSTRACT

As information technology (IT) becomes more accessible, sustaining any competitive advantage from it becomes challenging. This has caused some critics to dismiss IT as a less valuable resource. We argue that, in addition to being able to generate strategic advantage, IT should also be viewed as a strategic necessity that prevents competitive disadvantage in rapidly changing business environments. We test a set of hypotheses on strategic advantage and strategic necessity in the context of Internet banking investments among the entire population of the United States Federal Deposit Insurance Corporation (FDIC) banks from 2003 to 2005. We seek to understand whether their IT investments were made as a strategic choice, or as a result of strategic necessity. Our econometric analysis suggests that IT investments: (1) were made to complement firm strategy for strategic advantage, as well as due to strategic necessity; and (2) paid off by enhancing firm performance and addressing the issue of strategic necessity in an effective way. In addition, our analysis revealed a simultaneous relationship between performance and IT investments, so that high-performing banking firms appear to have been more likely to invest in IT.

Keywords: Banking, econometrics, Internet banking, simultaneity, strategy, transaction costs

---

Acknowledgments. We benefited from the comments of Eric Clemons, Thomas Weber, Abraham Seidmann, Eric Johnson, Andrew Whinston and the participants of 25th Anniversary Symposium of the Competitive Strategy, Economics and Information Systems Mini-Track at 2013 Hawaii International Conference on Systems Science, where we presented an earlier version in January 2013. The authors thank the U.S. Federal Deposit Insurance Corporation (FDIC) for providing the data for this study. Kim Huat Goh thanks Nanyang Technological University for funding from various research grants. Rob Kauffman warmly acknowledges the Lee Kuan Yew Faculty Fellowship for Research Excellence at Singapore Management University for generous support.

"[*IT*] *may be strategically important, not because it gives you strategic advantage, but because failing to attend to it results in strategic disadvantage."*

- Eric K. Clemons and Steve O. Kimbrough, Wharton School, University of Pennsylvania [19]

"[*In 2001, banks*] *offering transactional Internet sites were more profitable than those that did not. This reflects the choice of profitable banks to adopt the technology, rather than profitability from Internet services."*

- Allen N. Berger, Economist, Board of Governors, Federal Reserve System [11]

1. INTRODUCTION

Advances in information technology (IT) have enabled firms to extend their business models and improve their business processes. Senior managers hope to gain strategic advantage by investing in IT, but as technology becomes pervasive and more accessible, sustaining any strategic advantage becomes a challenge. Some authors have dismissed IT as a non-essential asset though, based on their belief that it does not yield sustainable competitive advantage [16, 47, 49]. In this article, we argue that, although IT is increasingly common across firms, its importance should not be underestimated, and there are more current and more insightful ways to think about the value it creates. Our view builds on past thinking: by not investing in IT, firms will face sustained disadvantage in changing environments, while their competitors move rapidly to invest in accessible, potentially high return-on-investment (ROI) technologies. Our view is that IT has become a strategic necessity for most firms. The minimum required investment in technology-based competition is constantly rising, making IT investments essential for firms to do business.

Clemons and Kimbrough [19] and Clemons and McFarlan [20] first proposed the idea of the *strategic necessity of information technology* (IT). The early literature in the 1980s challenged senior managers to think about strategic advantage and the strategic necessity of IT investments, and distinguished the differences between them. Clemons [17] argued that IT investments were important to a firm because they afford *strategic advantage.* This is the *strategic advantage perspective*, which became the dominant view. Clemons and his coauthors have noted that IT investments have to be made because all players in the market may adopt technology-based solutions, leading to an "arms race" of technology-based competition. This view, the *strategic necessity perspective* for IT investments, argues that they are essential for doing

business. Both perspectives point toward the benefits of IT, but distinguishing between the effects of IT value as supporting competitive strategy or addressing a strategic necessity is an important empirical issue.

Past research and practice have focused more on the value of IT from a strategic advantage perspective; the strategic necessity perspective has been an afterthought [28]. To our knowledge, there have been no empirical studies that validate the strategic necessity of IT either. If senior managers focusing only on the strategic advantage of IT, they are likely to under-estimate the business value of IT, which leads to the further possibility that their firms will under-invest in IT [19]. In this article, we establish empirical evidence to suggest how IT investments are made to pursue strategic advantage and recognize strategic necessity, and also provide a means to test the relevant theory proposed in earlier works.

The lack of empirical studies on IT as a strategic necessity should not be surprising. A comprehensive empirical study to examine the motivation behind IT investments requires a large data set that captures information about firms that invested or did not invest in IT. Obtaining data for firm-level IT investment decisions typically is difficult enough. The data are likely to be censored, and firms that do not invest are less likely to participate or be the targets of the data collection process in such studies. In addition, appropriate data need to capture the different investment decisions of these firms over time. Data that meet these requirements are especially difficult to come by, which explains the lack of empirical work.

We conducted this study in the context of Internet banking investments by American commercial and retail banks from 2003 to 2005. We will apply strategic management and transaction costs thinking to analyze Internet banking-related IT investments made by all of the banks in the United States that were insured by the Federal Insurance Deposit Corporation (FDIC) during the period of observation. To our knowledge, this is the first empirical study that analyzes the entire population of American commercial banks, their Internet banking investments, and the strategic implications for performance that have resulted from them over time. Internet banking services are supported by relatively mature technologies now. They also have characteristics that make the financial services context appropriate for examining the returns to IT investments related to strategic necessity. The competitive environment of commercial banking is well-suited to examining how strategic advantage and strategic necessity affect IT investments too.

Further, the debate about the impacts of Internet banking on bank performance highlights the importance of this research and calls for additional empirical investigation [11, 25, 30].

To examine the benefits of Internet banking, we will consider simultaneous effects among the drivers of IT investments and the related impacts that can be measured. Regressing IT spending on performance indictors does not provide a robust or deeply insightful approach for drawing conclusions about the benefits of IT spending, since high performance banks have a greater propensity to invest in IT due to the availability of resources [2, 14, 57]. Similarly, to isolate strategic advantage from strategic necessity as the driving force for IT investment, we must consider the same issues of simultaneity: profitable banks also may invest in IT out of strategic necessity to maintain their performance.

In this study, we confirmed that IT investments are made for strategic advantage and strategic necessity reasons. The motivation for necessity-based IT investments appears to have been increasing over time, while the motivation for IT investments for strategic advantage appears to have been decreasing. IT investments also are associated with bank transaction cost savings and more consumer deposits. Finally, we found evidence for the presence of simultaneity: better performing banks have been more likely to invest in Internet banking-related IT investments.

Section 2 describes the American financial services industry, and Section 3 discusses the theoretical foundations for this research. Section 4 lays out our hypotheses related to Internet banking IT investments. Section 5 presents our model, data and methods. Section 6 interprets the findings, and Section 7 discusses their robustness, and the sensitivity and the simultaneity of the key relationships. We also identify temporal variations in Internet banking investments and their lagged effects. Section 8 concludes.

2. INTERNET BANKING AND AMERICAN FINANCIAL SERVICES

The commercial and retail banking industry has been the most IT-intensive industry in the U.S. for at least thirty years [55]. IT supports a range of bank operations, from customer-oriented front-office services, to financial risk management-focused middle office functions, to efficiency-driven back-office processes that have become essential capabilities [27]. The introduction of Internet banking technology to

support online transactions has provided banks with new ways to reduce transaction costs, and a new channel for reaching out to new and younger customers [11, 34].

The banking industry is highly competitive and banks that are market leaders often adopt new technologies to be more competitive. Various studies in the banking and financial services literature suggest that banks adopted Internet banking to retain their customers, and Internet-capable banks have been more profitable [11, 30]. Critics, meanwhile, have argued for the presence of *simultaneity*. Profitable banks have more financial and human resources to invest successfully in IT. They are more likely to implement Internet banking out of strategic necessity in competitive environments [36]. The simultaneity between Internet banking and performance remains an empirical question though, since rigorous evidence has yet to be reported [11, 35, 36]. Recent research has shown that Internet-only banks may under-perform compared to other new banks operating in multiple channels [30]. When Internet-only banks accumulate sufficient experience, the technologies they use create scale effects for firm expansion, supporting profitability and growth. These benefits are built on the alignment between IT capabilities and corporate strategy.

Although some Internet banking systems result from proprietary in-house development, the industry has many technology vendors that customize applications from off-the-shelf solutions [6]. Unlike off-the-shelf technology, proprietary technologies and systems are not available to competitors. This can be a source of advantage that leads to greater strategic importance for IT investments [58]. The wide range of IT in financial services often makes such investment a strategic choice on the bank's part, but there may be just as many opportunity to invest in IT due to strategic necessity. Commercial banking mirrors other industries though: advances in IT have made it so that few industries are driven very much by proprietary technologies anymore. So the study of IT investments for strategy and necessity reasons in the banking industry are likely to be generalizable to IT investments across different industry settings and contexts.

3. THEORETICAL BACKGROUND

3.1. Strategic Advantage Versus Strategic Necessity

We next review the theoretical underpinnings of strategic advantage and strategic necessity. A firm's

investment in IT achieves s*trategic advantage* if it brings about better than normal returns [17, 46]. To gain strategic advantage from IT, the firm has to operate in an environment in which there are barriers to the replication of value from the IT investment. Competitors should not be able to duplicate the investment quickly and achieve the same impacts [19]. ITs that become readily accessible within the market may create benefits for a firm that adopts it early; however, such benefits are likely to be gained industry-wide and not afford strategic advantage for any individual firm.

To establish strategic advantage when IT is involved, the firm's strategy has to be aligned with its IT investments [23]. In order to gauge the impacts of IT for strategic advantage, it is necessary to be able to observe and quantify the outcomes associated with the firm's execution of its strategy. Firm strategy is the *positioning* of an organization in the market, reflected by its product, service and market choices, and the competitive advantage it is able to achieve [12]. Porter [46] defined *firm strategy* as a deliberate plan to choose a set of value activities that will deliver a unique mix of value. IT is widely believed to facilitate the design of value-driven firm strategy [29, 45]. Investments in IT also provide *digital options* for the firm in the formulation of new strategic opportunities for sustainable advantage [10, 51]. Other studies have suggested that, in order to gain strategic advantage, firms must also consider the strategic role of complementary non-IT resources [22, 43].

Unlike strategic advantage, strategic necessity has been studied less. Clemons and Kimbrough [19] defined *strategic necessity* as an essential condition or action required by a firm to remain viable in the business environment in which it operates. Strategic necessity is influenced by external factors, and the business environment in which the firm operates determines the extent of the impacts that IT can have. This external pressure gives the firm limited flexibility in investment decision-making.

We will model strategic necessity and its effects as a simultaneous relationship. Firms exhibit interdependence in a competitive industry and maintain their competitive positions through self-regulation [56]. The pressures experienced by firms in the business environment signal the need for a firm to remain competitive, and the kinds of actions that are warranted. See Figure 1.

INSERT FIGURE 1 ABOUT HERE

The figure suggests that strategic necessity drives the firm's IT investments, and such investments reduce the pressure the firm is experiencing, by enhancing its capabilities.

3.2. Transaction Costs, Search Costs and IT

Banking is transaction-intensive and a significant portion of the industry's operational costs involve handling information and processing transactions [24]. The costs of maintaining a relationship between a customer and the bank are high, so managing these costs is essential for higher profitability. Transaction cost economics recognizes the importance of transaction costs in market exchanges, including the time, effort and other direct costs associated with searching, negotiating, monitoring and completing transactions [59]. In addition to the market coordination costs, operational risks and opportunism risks are associated with the transaction costs and the reduction in control in moving from a hierarchical activity within the firm to a market activity [21]. The IS literature provides strong evidence to suggest that IT is facilitating and promoting more market transaction activity due to the lower associated transaction costs.[1]

One relevant component of transaction costs is buyer search costs, which are influenced by the nature of the market.[2] IT reduces search costs by facilitating the distribution of search information across markets. This is critical for differentiated markets in which rich search information needs to be effectively communicated to maintain reasonable search costs to prevent market failure [5]. The Web is a channel that promotes information transmission and bank customers benefit by conducting more efficient Internet searches for financial products that fit their preferences.

4. HYPOTHESIS DEVELOPMENT

We next develop the hypotheses that we will test in the subsequent sections.

---

[1] IT increases information availability and processing capacity to facilitate monitoring of market activities. Malone et al. [42] suggested that IT reduces the cost of exchanging and processing information, reducing the unit cost of coordination. IT is increasingly standardized and interoperable though, reflecting technology commoditization, reducing the relationship-specificity of IT investments and increasing the firm vulnerability in a changing market.

[2] In commodity markets where sellers offer identical products, search provides information about the existence and price of the product. High search costs lead to market inefficiency though, and they also promote monopolistic pricing [53]. In differentiated product markets, search is more costly and is necessary to provide additional information on the product so that transactions are possible. Profit opportunities are available as a result of buyer heterogeneity and the search costs are higher due to the higher information content [5].

4.1. Strategic Advantage, Firm Strategy and IT

Recall that firm strategy can be viewed as the combination of a firm's value propositions with a set of value activities that facilitate their achievement. A close fit between the firm's value propositions and its value activities is essential to achieve strategic advantage. This matching can be observed in the banking industry. We will describe how a bank's loan distribution strategy (as a basis for delivering its value proposition to the marketplace) is matched with its Internet banking investment (as an expression of its capacity to support its value activities).

Internet banking augments operations by providing an additional channel to serve customers. It is suited to commoditized services, including funds transfer, credit card applications, balance inquiries and bill payments. Internet banking alleviates the transactional load from branches, reducing the bank's overhead expenses. Internet banking also is well suited to support *transactional lending* [30]. Transactional loans are made to borrowers with the aid of objective metrics from electronic credit scoring models and risk assessment tools. The risk of the bank is managed by diversifying and securitizing relatively homogenous loans, such as personal lines of credit, and auto, mortgage and credit card loans. Services that transactional lending customers require can often be provided through Internet banking. It acts as a substitute for more costly face-to-face interactions with banking staff members. This aspect of Internet banking provides greater scale benefits and is an IT-based enabler of bank growth [24].

Internet banking services, however, are ill-suited for handling *relationship lending*, in which the borrowers' risk is assessed by subjective metrics, such as personal knowledge and monitoring of idiosyncratic borrowers [30]. Examples of relationship lending include small business loans and farm loans. With the exception of providing generic bank information for advertising on the banks' websites, Internet banking provides limited support for relationship lending activities. There is not a good substitute for a customer's personal interactions with branch banking staff for such services.

A bank's loan distribution strategy, based on its choices of products or its domain of market operations, has to be matched with its corporate IT strategy. Banks that mainly focus on transactional lending, like credit card loans, should consider providing extensive Internet banking services as opposed to banks

that focus more on relationship lending, like agricultural and community banks. Based on this argument, a bank's conscious choice to adopt Internet banking to match its loan distribution approach is a classic way to implement IT for strategic advantage. This suggests:

- **Hypothesis 1 (Strategy-IT Alignment).** *Internet banking investment is impacted by the bank loan's distribution strategy: more transactional lending increases its likelihood of Internet banking investment compared to relationship lending.*

4.2. Strategic Necessity in Commercial Banking

There are a variety of strategic necessity pressures that may affect investment decision-making for Internet banking services. Two key pressures influence Internet banking investments: the need to compete for customer deposits to increase a bank's access to capital, and the need to manage high transaction costs.

Banking is transaction-based. The labor and infrastructure required to execute transactions result in high transaction costs and profit pressure. The industry also is highly competitive, and banks strive to be cost-effective, through outsourcing and business process re-engineering, among other remedies [3]. Internet banking is a potential cost-savings tool. Banks that implement it can channel standardized, high-volume low-value transactions to the web to reduce their expenses. This permits them to operate with narrower spreads, by offering higher deposit rates and lower loan rates [30].[3] Narrower spreads allow banks to be profitable and grow in *competitive environments*, by attracting deposits and loans more readily than competitors, resulting in higher profits. In a competitive environment, cost management is crucial. As a result, banks will invest in Internet banking out of strategic necessity. We assert:

- **Hypothesis 2 (Transaction Costs-Based IT Investment Necessity).** *Banks facing high transaction costs are more likely to invest in Internet banking out of strategic necessity to reduce costs and remain competitive.*

Banks finance illiquid investments by using short-term liabilities, such as inter-bank loans and customer deposits. They also compete for deposits to establish a stable source of capital to fund their lending and deal portfolios. When capital is in short supply, banks must supplement deposit-taking by borrowing short-term funds from large institutions that are perpetually rolled over, a practice known as *liability*

[3] An *interest rate spread* is the difference between the rate at which money is deposited in a financial institution and the higher rate at which the bank loans funds. The relationship between the rates determines a bank's earning ability.

management banking [54]. This practice is risky and poor management may lead to bank failure, if the bank loses its creditworthiness and is unable to roll over its borrowings. The scale of debt recall by institutional creditors can cause significant liquidity risk as well.[4]

One way of mitigating this risk is to capture more deposits, reducing the bank's need to borrow money in the short-term market. Deposits provide a lower-risk alternative for obtaining funds, and the risks are indemnified by federal deposit insurance [15], which diminishes banking customers' uncertainty discount on the deposit interest rate they will accept. Internet banking reduces customer search costs, and potential customers are able find banks that otherwise would be unavailable due to geographical constraints. In addition, Internet banking lowers the coordination costs for the bank customer. So some banking transactions can be performed with greater convenience through this channel. To attract deposits in a competitive banking environment, banks are compelled to adopt Internet banking out of strategic necessity to extend their reach to potential depositors [24, 36]. On this basis, we propose:

- **Hypothesis 3 (Deposit-Based Funding IT Investment Necessity).** *Banks that face pressure in obtaining funding from consumer deposits are more likely to invest in Internet banking out of strategic necessity.*

We hypothesized that higher transaction costs and a lower level of deposits have positive effects on the decision to invest and implement Internet banking. By adopting Internet banking, banks expect the technology to decrease their transaction costs through streamlined operations. Similarly, Internet banking will cause an increase in deposits through better sourcing capabilities and scope [24, 26, 44]. Adopting Internet banking thus creates countervailing effects on the strategic necessity pressures driving the adoption decision. To test these relationships, we offer:

- **Hypothesis 4a (Transaction Costs Simultaneity).** *Internet banking services decrease transaction costs for the bank, thus reducing the pressure of cost competition.*

- **Hypothesis 4b (Deposits Simultaneity).** *Internet banking services increase customer deposits, thus reducing the pressure associated with the overall cost of funding.*

[4] The riskiness of interbank liability management was demonstrated by the sudden bankruptcy of Lehman Brothers Holdings in 2008. Lehman Brothers alleged that its bankruptcy was caused by a massive liquidity shortfall when J.P. Morgan demanded US$8.6 billion of additional collateral the weekend prior to Lehman's collapse. The additional collateral was called to guarantee interbank liability positions.

4.3. IT and Bank Performance

The IS literature has many studies that investigate the relationship between IT and firm performance. Using different units of analysis and separate measures for IT and performance, these studies have confirmed the role that IT typically plays in value creation. The studies have indicated that firm structure, business characteristics such as workforce composition, firm risk profile, scale of operations and organizational knowledge establish the conditions that make or break the value creation process [28, 57].

From the literature, we recognize the significance of establishing an accurate representation of the relationship between IT and its outcomes. With the exception of a handful of studies [2, 4, 57], the issue of simultaneity between IT and its outcomes is often understated. Although the empirical evidence on the impact of Internet banking on bank performance is far from conclusive, the finance literature suggests an inherent simultaneity between Internet banking and bank performance [11, 30, 35]. Internet banking seems to have a positive impact of bank performance [24, 30], and it is widely accepted that high performance banks are more likely to invest in Internet banking, since they have slack resources. In addition, some studies suggest that, due to their greater flexibility, high performance banks are more likely to adopt Internet banking to retain their customer bases and remain competitive [11, 24]. So we propose:

- **Hypothesis 5 (IT and Performance Simultaneity).** *Internet banking investments positively influence bank performance, and high bank performance positively and simultaneously influences the decision to invest in Internet banking.*

5. DATA AND MODEL

5.1. Data and Descriptive Statistics

The data for this study consist of the entire population of American banks that were insured by the FDIC over a three-year period from 2003 to 2005. The population contains only banks that engaged in the commercial and retail banking activities, excluding investment banking, asset management or trading activities, which would confound the information in the findings we report. The key descriptive statistics of the variables used in our empirical model are exhibited in Table 1.

INSERT TABLE 1 ABOUT HERE

We collected a total of 23,250 observations. The annual panel data were obtained from the FDIC, which uniquely identifies each bank by its Federal Reserve Identification Number across the years. Since the data represent the entire population, we are able to mitigate sample selection bias. The FDIC requires all banks it insures to provide quarterly reports on various aspects of their operations, so it can monitor and assess their overall financial condition. The data we obtained constitute a subset of the information the FDIC collects. It captures the presence or absence of Internet banking systems as a binary variable, along with numerous financial and non-financial indicators that reflect the overall operations of the banks. A bank is coded as having Internet banking technology if its website can support financial transactions between the bank and its retail consumers. A bank with a website that only provides information to consumers, is not coded as having implemented Internet banking technology. We chose *financial transactional capability* as the selection criterion; it captures both demand and supply side impacts. First, transactional capabilities increase deposits, as they enhance the reach of the bank by supporting depositors from different geographical locations. These consumers are able to transact with the bank by depositing funds into or transferring funds from accounts held by the bank. On the supply side, Internet technologies reduce the operational load for physical bank branches, so fewer tellers can handle a larger customer base.

5.2. Controls and Proxies

We took two steps to create a rigorous basis for our empirical results. First, we specified an appropriate research model by including suitable proxies and the necessary controls. Second, we considered alternative estimation methods and developed stronger results through their use. We next will discuss the first step of identifying the necessary proxies and controls for estimation.

We use a variety of firm-level control variables to account for variations across banks, as well as environmental variables to control for macro-socioeconomic fluctuations. We adopted firm-level control variables suggested in the banking literature that examines Internet banking use and bank performance. We used the natural log of total bank assets (*lnAssets*) to control for the effects of different operating scale on bank performance [30]. The number of bank branches (#*Branches*) accounts for the size of the branch network, which affects a firm's propensity to adopt Internet banking [24]. Since differences in bank risks

also may change the likelihood that a firm will make Web investments, and it may affect the bank's performance, we control for this using the percentage of non-current loans to total loans (*%NCLoans*). This is a common proxy used in other bank performance studies [30, 33]. A larger ratio suggests that the bank is in a higher risk condition, which may lead to greater uncertainty about the bank's future performance. We use percentage of real estate owned (*%RealEstate*) to control for the effects of loan portfolio mix on bank input mix requirements, earnings, growth and other performance measures [30]. We further control for bank experience, proxied by the bank's *Age*. This affects bank profitability and a firm's ability to utilize advanced technology, especially in start-ups [50]. And, the natural logs of total bank loans (*lnLoans*) and the number of employees (*ln#Employees*) serve as control variables for bank transaction costs.

To account for socioeconomic differences in a bank's home state *j*, we coded 50 dummy variables for the fifty states, with Washington, DC as the base case. This enabled us to control for differences among bank consumers by location, which may affect the banks' operations. To control for possible environmental impacts, such as interest rate fluctuations, economic cycles and regulatory changes that might bias the results, we applied fixed-effects estimation. We also included the number of employees laid off (*#Layoffs*) from the banking sector due to outsourcing at the state level to control for outsourcing activities as a proxy for other structural changes the banks could be experiencing in the business environment [52]. We chose fixed-effects over random-effects estimation because the latter assumes that any information related to time in the error term is uncorrelated with the independent variables [60].[5]

We utilized various proxies to represent the rest of the variables in our analysis. Transaction costs are measured by the natural logarithm of premise and equipment costs (*lnTransCosts*), which represent all costs related to maintaining the physical presence of bank branches, excluding employee costs. Customer deposits are measured by the natural logarithm of total interest-bearing bank deposits (*lnDeposits*). We use the natural logarithm of transactional lending (*lnTransLending*) and the natural logarithm of relation-

[5] This is unrealistic in our setting. The environmental impacts for which we are controlling are likely to be correlated with the independent variables in our model. For example, a change in interest rates due to some environmental impact is likely to be correlated with the amount of lending, total deposits and even the percentage of non-current loans as independent variables.

ship lending (*lnRelLending*) to represent the bank's loan distribution strategy. Transactional lending includes credit card loans, personal overdrafts, auto loans and home mortgages, and relationship lending includes small business and farm loans [30].

Although the benefits of IT can be observed at the process level, studies have also found a positive association between IT and other levels of organizational outcomes, such as firm revenue and net income [28]. Since we are focusing on the process-level impacts of Internet banking, such as decreasing transaction costs and increasing bank deposits, we use the natural logarithms of gross revenue (*lnRevenue*) and net income (*lnNetIncome*) to proxy for the firm-level impacts of Web investments. These proxies of bank performance are widely accepted in banking and financial services [31].

5.3. Model and Methods

Our proposed research model organizes our hypotheses relative to the key constructs. (See Figure 2.)

INSERT FIGURE 2 ABOUT HERE

The model realistically suggests that IT investment is motivated by both the need to match firm strategy for strategic advantage, as well as by strategic necessity. This ensures that all of the hypotheses can be tested in a simultaneous fashion. In econometric terms, the empirical model is a simultaneous equation system that consists of Internet banking adoption (a binary variable), bank transaction costs, bank deposits and bank performance – all as endogenous variables. The other variables in the structural equations are exogenous variables. We represent the research model as two systems of equations, each denoted by a dotted-line box in Figure 2. The first system of equations – the *Firm Strategy and Strategic Necessity System* (hereafter the *FSSN System*) – examines the effects of firm strategy for strategic advantage, and strategic necessity on Internet banking simultaneously. The second system of equations – the *IT-Performance System* – examines the simultaneous impact of Internet banking on bank performance.

For both systems of equations, the first equation in the system is represented by:

$$Y = Z\,\Psi + v \qquad (1)$$

where Y is a non-discrete dependent variable. Depending on the system of equations to be estimated, the dependent variable can represent transaction costs, deposits, revenue or net operating income. Z

represents a vector with one constant and multiple independent variables, Ψ represents the parameters and *v* represents the residuals.

For both systems, the second equation in the system is a binary dependent variable, representing Web banking. We use a probit link to estimate π_{web}, the probability that a firm will implement Internet banking:

$$\Phi^{-1}(\pi_{web}) = X\,\beta + \varepsilon \qquad (2)$$

where Φ^{-1} is the inverse of the cumulative standard normal distribution function, X represents a vector of one constant and multiple independent variables that impact the implementation of Internet banking, β represents the parameters of the regression model to be estimated, and ε is a random error.

We estimated the FSSN System twice, first using transaction costs as a driver for strategic necessity, and then using the amount of bank deposits as the other driver. *lnTranCost* and *lnDeposit* represent the dependent variables for the first equation in each system. We also ran two sets of analyses for the IT-Performance System with two proxies for bank performance (*lnRevenue* and *lnNetIncome*) as the dependent variables. To estimate the simultaneity between the endogenous variables, we used *two-stage probit least squares* (2SPLS) to solve for the system of equations [39, 41]. Our system of equations contains discrete and continuous endogenous variables, rendering other simultaneous equation approaches such as three-stage least squares and full information maximum likelihood estimation inappropriate [39, 40]. More importantly, two-stage estimation requires fewer exclusionary restrictions for model identification. In general, fewer assumptions lead to more realistic models [37]. This two-stage approach involves estimation of the reduced-form equations for each endogenous variable via least squares or probit, depending on the variable type. The estimators from the reduced-form equations are used to predict the values of the endogenous variables, which are then substituted into the right-hand side of the structural equations. [6]

[6] We checked the identification of the model and equations using the rank and order conditions [37]. We tested the estimation results for autocorrelation using the Durbin-Watson test for panel data and found no evidence that it was an issue [60]. We computed the condition numbers of the moment matrix [9], and found that all of the values were below 20. This means that multicollinearity also is not an issue in the model.

6. RESULTS

We next discuss the results from estimating the simultaneous equations. We lay out the impacts of strategic necessity and firm strategy on Internet banking investments, followed by the effects of Internet banking on performance, and will discuss the results of our simultaneity and robustness tests.

6.1. Strategic Advantage or Strategic Necessity?

Overall, the regression results from FSSN System and the IT-Performance System provide empirical support for our research model. (See Table 2.)

INSERT TABLE 2 ABOUT HERE

Each column represents one set of simultaneous equations with transaction costs, deposits, revenue or net operating income as a dependent variable for the first equation and the investment in Web banking as a binary dependent variable for the second equation. In all four probit equations, the coefficient of transactional lending is at least twice that of relationship lending, with the ratio between these coefficients ranging from 2.070 to 2.936. This ratio measures the relative difference in magnitude between transactional lending and relationship lending in impacting the decision to invest in Internet banking. The consistency exhibited by the estimates from the four different systems of equations provides strong support for this finding. Our results show that transactional lending increases the probability of implementing Internet banking by at least twice compared to relationship lending, supporting the Strategy-IT Alignment Hypothesis (H1). For every unit increase in transactional lending, we expect banks to be more likely to adopt Internet banking compared to a similar increase in relationship lending. This result suggests that the bank's loan distribution strategy, as a proportion of transactional lending compared to relationship lending, affects its propensity to invest in Internet banking.

The coefficient of transaction costs for Internet adoption in the FSSN System (for *lnTransCosts*, Table 2, Column 1) is positive and significant (*lnTransCosts* = 0.524, SE = 0.032, $p < 0.001$), so higher transaction costs lead to a bank's higher likelihood of investing in Internet banking. Banks that experience high levels of transaction costs from brick-and-mortar operations will experience pressure to control costs. Investing in Internet banking will become a strategic necessity to streamline the operations of physical

bank branches. Internet banking also provides another channel to move various banking activities into. These results support the Transaction Costs-Based IT Investment Necessity Hypothesis (H2).

Implementation of Internet banking as a strategic necessity due to pressure to gather more customer deposits is shown in the FSSN System (for *lnDeposits*, Table 2, Column 2). The coefficient on customer deposits is negative and significant (*lnDeposits* = -1.431, SE = 0.368, $p < 0.001$). This suggests that after controlling for bank characteristics, loan distribution strategy and environmental differences, banks that have fewer deposits are more likely to invest in Internet banking. They will do this to bring in more customers and gain more deposits. With the support shown for the first three hypotheses, we preliminarily conclude that Internet banking investments are driven by both strategic choice and strategic necessity. As a strategic choice, Internet banking investments are aligned with the banks' loan distribution strategies. As a strategic necessity, Internet banking adoption is driven by the pressures to maintain cost effectiveness, as well as the need to gather more funds through higher deposit levels.

6.2. Visualizing the Differences in Strategic Necessity and Strategic Advantage

To visualize the effects of strategic necessity and firm strategy on Internet banking investment impact, we plotted the conditional probability distribution of the 2SPLS model for the FSSN System with transaction costs and Web banking as dependent variables (results from Table 2, Column 1).[7] We substituted the mean values for all of the variables in the probit portion of the simultaneous equations model, with the exception of the independent variables of interest (*lnTransCosts* for strategic necessity and *lnTransLending* for firm strategy). The curve on the left in Figure 3 shows the probability distribution of Internet banking implementations relative to the average bank in 2004. (See Figure 3.)

INSERT FIGURE 3 ABOUT HERE

When the transaction costs of a bank are increased by one standard deviation, σ, the curve shifts to the right and the probability of Internet banking implementation increases from 0.457 to 0.737. Similarly, for the probability distribution of firm strategy, an increase in transactional lending by one standard devia-

[7] The purpose of the graphs is to visualize the shifts in probability for an average bank. We provide statistical evidence of the difference by computing the Wald χ^2 statistic. We found that both standardized coefficients for *lnTransCosts* and *lnTransLending* are significantly different ($\chi^2 = 17.72$, $p < 0.001$).

tion leads to an increase in the probability of Internet banking adoption from 0.457 to 0.653. (See Figure 4.) We observe that, for an average commercial bank, if its transaction costs are increased by one standard deviation, it will more likely be associated with an investment of Web banking compared to if its transactional lending is increased by one standard deviation.

INSERT FIGURE 4 ABOUT HERE

Comparing Figures 3 and 4, we see that the increase in probability of Internet banking adoption is more sensitive to increases in transaction costs than an equivalent increase in transactional lending. So, despite the fact that both strategic necessity and firm strategy appear to influence banks' decisions to implement Internet banking, on average, their decisions are influenced more by strategic necessity.

6.3. Impacts of Internet Banking and Bank Performance

We now discuss our test results for the Hypothesis 4 group. We found the implementation of Internet banking to be effective in reducing the transaction costs for the bank (Transaction Cost Simultaneity Hypothesis, H4a). The coefficient of the *Web* variable in the FSSN System (for *lnTransCosts*, Table 2, Column 1) is negative and significant (*Web* = -0.076, SE = 0.019, $p < 0.001$). Based on our results, banks that invest in Internet banking incur $1 - e^{-0.076} = 7.3\%$ lower transaction costs. Although high transaction costs prompt Internet banking, simultaneity between the pressure of strategic necessity and the effects of Internet banking causes a recursive impact, reducing the magnitude of transaction cost pressure after the implementation of Internet banking. We further found that Internet banking is positively associated with higher levels of bank deposits (*Web* = 0.257, SE = 0.013, $p < 0.001$). This enables us to estimate that banks that invested in Internet banking gathered $e^{0.257} - 1 = 29.3\%$ more deposits than those that did not. Given that banks facing a shortage of customer deposits are more likely to implement Internet banking out of strategic necessity, it is clear that their investments pay off through increased bank deposits. This has the added benefit of reducing the pressure on the bank's funding costs. This support for the Transaction Cost Simultaneity Hypothesis (H4a) and the Deposits Simultaneity Hypothesis (H4b) leads us to conclude that Internet banking is effective in diminishing strategic necessity pressures through process-level benefits. This helps the firm to maintain a consistent level of competitiveness in spite of other disad-

vantageous changes in the changing business environment.

Our results from the estimation of the IT-Performance System model (Table 2, Columns 3 and 4) show that Internet banking is positively associated with bank revenue (Column 3, *Web* = 0.135, SE = 0.029. $p < 0.001$) and net operating income (Column 4, *Web* = 0.165, SE = 0.029, $p < 0.001$). Based on our estimation results, Internet banking investment is associated with an increase of $e^{0.135} - 1 = 14.5\%$ in bank revenue and an increase of $e^{0.166} - 1 = 18.1\%$ in net operating income. This matches some of the findings in the IT and banking literature [28, 30]. Our findings also point to simultaneity between Web investment and bank performance. Our test of the connection between Internet banking and performance provides support for the IT-Performance Simultaneity Hypothesis (H5). But how robust are our results?

6.4. Robustness Check: Sensitivity and Simultaneity Analysis

To ensure that our 2SPLS estimates are robust, we triangulated across multiple estimators for our empirical model. Rivers and Vuong [48] proposed a more computationally complex *two-stage conditional maximum likelihood* (2SCML) estimation approach as an alternative to simultaneous equations with discrete dependent variables. Alvarez and Glasgow [1] showed that 2SPLS outperforms 2SCML in terms of consistency, but 2SCML is more efficient asymptotically since 2SCML reaches the Cramer-Rao lower bound in large and in small samples. We re-estimated the 2SPLS results in Table 2 using 2SCML and compared the results of both methods. (See Appendix A for the econometric specification.) The results that we obtained from our 2SCML estimation (not presented here due to space limitations) were similar to the earlier 2SPLS estimates. They provided identical support for all of our five hypotheses (all relevant variables with $p < 0.001$). The 2SCML estimators also are a practical means of testing for simultaneity.

Unlike past work that assumes simultaneous impacts of IT [2, 57], in this study we are testing for the presence of simultaneity itself, represented by the dotted arrows in Figure 2, using formal statistical techniques. (See Figure 2 again.) We first removed all of the recursive links between Web investment, performance and strategic necessity pressure, denoted by the dotted arrows in the figure. This resulted in the elimination of the non-probit equation for the FSSN System and the probit equation in the IT-Performance System. We estimated the remaining equations in the FSSN System individually using pro-

bit regression. We also ran the remaining equation in the IT-Performance System using ordinary least squares regression. These estimators constitute the restricted estimators in our simultaneity tests.

For the FSSN System, we used the unrestricted estimators from the 2SCML to formally test for the presence of these endogenous relationships. Rivers and Vuong [48] have shown that the properties of the 2SCML estimators are well-suited for conventional likelihood ratio tests. For both equations in the FSSN System, our tests suggest the presence of simultaneity ($p < 0.01$). For the IT-Performance system, we used estimates from the 2SPLS to test for endogeneity. For the FSSN System equations, our modified Hausman tests suggest simultaneity is present ($p < 0.01$). (See Appendix A.)

Both the likelihood ratio tests and the modified Hausman tests which we conducted suggest that, by accounting for simultaneity between IT investment and bank performance, and between IT investment and strategic necessity pressures, more consistent estimates of the relationships between these constructs can be obtained. The test results affirm the design of our research model and increase our confidence about the conclusions that can be drawn related to our key hypotheses and theory in this work.

7. EXTENDED RESULTS AND DISCUSSION

Our results have shown that firm strategy and strategic necessity affect Internet banking investment decision-making. But to what extent does this vary over time? And, if so, what are the implications. To examine these issues, we segregated each of the years of data in our three-year panel. We conducted the 2SPLS regression on the FSSN System for *lnTransCosts* and *lnDeposits* three times, once each for 2003, 2004 and 2005. We wished to identify any potential variation that was occurring over time. (See Table 3.)

INSERT TABLE 3 ABOUT HERE

Our regression yielded similar results as the panel data analysis. In addition, all of the qualitative findings that we arrived at in our main analysis were supported. For all three years, both strategic necessity and firm strategy played a significant role in shaping the adoption of Internet banking. In these three years though, we observed that the ratio of the coefficients for transactional loans over relationship loans declined steadily from 3.819 to 1.548 in the Transaction Costs System (for *lnTransCosts*) and from 3.621

to 1.894 in the Deposits System (for *lnDeposits*). (See Figure 5a.) This suggests that, although the banks' loan distribution strategies were clearly driving the decisions to adopt Internet banking, the magnitude of this impact was eroding over the years. This observation is in line with the strategic advantage literature: strategic advantage will erode as more competitors enter the market and align their firm loan distribution strategies with the Internet banking investment.

INSERT FIGURES 5A AND 5B ABOUT HERE

In terms of strategic necessity, we also observed changing effects over time. (See Figure 5b.) For transaction costs as pressure toward strategic necessity, we observed that rising transaction costs have been a strong motivating factor behind the investments in Internet banking since 2003. The coefficients of *lnTransCosts* in our model steadily increased from 0.417 to 0.587 from 2003 to 2005. This signifies that, over time, the banks were more likely to invest in Internet banking as a strategic necessity due to the pressure of rising transaction costs. Banks' need to compete for deposits remained steady over the three years, and the magnitude of this factor's impact on investment in Internet banking increased from 2003 to 2005. In fact, from 2003 to 2005 the absolute value of the coefficient of *lnDeposits* steadily increased from 1.487 to 2.100.[8] This finding corroborates prior theory. As IT investments become pervasive, they gradually become essential for doing business and their justification as a strategic necessity gets stronger.

We observed another interesting finding. As we proposed in the Deposits Simultaneity Hypothesis (H4b), our estimation results indicate that the presence of Internet banking was associated with increases in bank deposits. Decreases in the relevant coefficients from 2003 to 2005 suggest that this impact diminished over time though. (See Figure 6a.) This finding is in line with our earlier hypotheses on strategic necessity. As more banks adopted Internet banking, the additional benefits of this technology in bringing in more deposits became diluted: application of this IT over time in the marketplace evened out the playing field among all of the market participants. Further, the introduction of Internet banking resulted in an immediate increase in the potential market size for the banks. This increase did not grow much with time,

[8] We used absolute values of *lnDeposits* for graphing Figure 5b for visual clarity. A more negative coefficient suggests that a drop in a unit of *lnDeposits* results in a larger probability of investing in Internet banking.

and as more depositors were acquired, the remaining untapped market decreased. Hence, all else equal, we should observe diminishing returns to scale for this effect over time.

INSERT FIGURES 6A AND 6B ABOUT HERE

For Internet banking impacts on transaction costs, apropos to our Transaction Cost Feedback Hypothesis (H4a), we observed that Internet banking investments were associated with reduced transaction costs in 2004 and 2005. In 2003, however, investments in Internet banking demonstrated a positive association with transaction costs. (See Figure 6b.) This result does not contradict our hypothesis though. We conclude, on the whole, that although the presence of Internet banking decreased banks' transaction costs in our panel data and during the individual years of 2004 and 2005, the cost savings took time to occur.

There are several possible reasons. First, the lowering of transaction costs involves redirecting loan transactions toward the Internet. This requires consumer education, as well as business process changes within the banks, however. The only benefit comes from lower transaction costs after effective business process changes have been instituted to re-engineer operations. Second, achieving a flow of benefits also takes time due to the necessity of encouraging consumers to shift to the online channel. The consumer product and technology adoption literature suggests that time is key in determining the cumulative number of adopters, and that consumer heterogeneity accounts for time lags in adoption [8]. Third, the fixed costs of maintaining branch premises and equipment represent a large proportion of the transaction costs in commercial banking operations. So, unlike variable costs, reducing fixed costs requires a longer time.

8. CONCLUSION

We empirically tested the extent to which IT investments for strategic advantage versus strategic necessity yield performance improvements in American commercial banking. We found that Internet banking technology investments are a component of the banks' overall competitive strategies, and they also reflect strategic necessity within the changing financial services industry. We found that strategic necessity is playing a more important role than strategic advantage in influencing IT investment decisions. Our data analysis shows that, over time, strategic necessity played an increasingly more important role than

strategic advantage in driving investments in Internet banking.

8.1. Contributions

Our study highlights the importance of viewing IT as a source of strategic advantage, as well as the importance of simultaneously viewing it as a strategic necessity. Though the theoretical underpinnings of this perspective were laid out in the 1980s, surprisingly, there has not been an empirical test during the past thirty years. We contribute by providing the first empirical evidence to understand strategic necessity in IT investments. We also have offered useful new managerial insights on IT investments in practice. We further hope that our results will influence business policy-makers to develop a more realistic view of how IT investments work in financial services and other industries[9].

Our research also contributes to theory. First, it develops theoretical explanations for the motivation behind different kinds of IT investments in commercial banking. We examined strategic advantage and strategic necessity related to IT in banking in a manner that has not been done before. Piccoli and Ives [45] have pointed out that this is an appropriate way to extend what we know about IT value. In addition, our research considers a key issue: simultaneity of investments and outcomes. This is a relatively well-recognized phenomenon in practice, but it has not been addressed fully or properly in the IT value literature. Our results offer compelling evidence for simultaneity, and suggest that future empirical research should consider these effects in greater detail to ensure more realistic managerial insights can be achieved.

This study also contributes new knowledge to practice. First, it offers insights about the overall effects of Internet banking on the commercial banking industry. By examining the entire population of FDIC-ensured commercial banks in the United States, we have been able to draw conclusions about the strategic and operational benefits of Internet banking. Our empirical evidence has implications for Internet banking investments related to loan distribution and banking operations. This gives bank managers broader justification for investing in Internet banking and a better appreciation of its impacts.

Our analysis also provides senior managers with new knowledge on the payoffs of investment in In-

[9] The strategic necessity perspective provides an additional important rationale for IT investment. This is essential to prevent underinvestment in IT by decision-makers who are proponents of IT investments for the sole purpose of strategic advantage [16, 49].

ternet banking. Such investments have diminished the pressures that banks have faced on the margin. These include the need to compete for more deposits to improve a bank's liquidity, and to reduce transactional costs to remain efficient. These process-level benefits are instrumental for high performance. Our results show that Internet banking investments were associated with a 7.3% drop in bank transaction costs and a 29.3% increase in bank deposits for FDIC banks during the years we studied. Further, we observed that Internet banking was positively associated with overall bank performance. Banks that invested in Internet banking service capabilities obtained an average of 14.6% more revenue and 18.1% higher net operating income. We evaluated these results by controlling for simultaneity between bank performance and a bank's likelihood to invest in Internet banking. By controlling for this simultaneity, we were able to ensure that the estimated positive impacts of Internet banking went beyond the effects that would be obtained when higher-performing banks exhibited a greater likelihood to invest in Internet banking.

8.2. Limitations and Future Research

Our research design has a number of limitations. One is the lack of more detailed information about Internet banking investments – a fact of life in the development of industry studies of IT investment. The discrete variable we used to represent Internet banking limited the statistical techniques we could apply, and constrains the conclusions we could draw. This limitation is compensated for by the fact that the data comprise the entire population of American commercial banks over a period of three years. This has allowed us to answer the research questions we posed with a greater level of confidence. Our data are well-suited to answering research questions related to banking firms that chose not to invest in Internet banking technology also, an important innovation in our work.

A second limitation involves the trade-off between power and generality, something that has been long recognized in the disciplines of technology, business and management. Highly specific systems typically are built as solutions to particular problems, and these may be complicated and context-specific. The success or failure of such solutions often is difficult to generalize to other situations. Systems with more general functionality (e.g., database systems, network and telecommunications systems, and accounting systems), on the other hand, are built as solutions for well-known business process domains. These do-

mains often are identified in association with over-simplified real-world problems, rather than with respect to the process and automation details they actually comprise. The returns to specific systems solutions are difficult to generalize from though the findings will be more accurate in financial terms, and the returns to more general systems solutions will be much harder to evaluate even though they will yield more generalizable insights. Our research has focused on the financial services industry. We provide insights on IT investments in commercial banking in the U.S. – an industry that has historically been a heavy investor in IT. As such, the conclusions that we have drawn may shed light on the practice of IT investments more generally, though our empirical results do not provide the broadest degree of generality.

Finally, although we report on the effects of Internet banking over a relevant time period as Internet banking was introduced, our research is still a nascent effort with respect to the more complex lagged effects of IT investments. More involved lagged models will require panel data covering more time. Further, since the main objective of this article has been to answer the more fundamental question of strategic advantage versus strategic necessity, we will leave the exploration of lagged models for future research.

REFERENCES

1. Alvarez, R.M., and Glasgow, G. Two-stage estimation of non-recursive choice models. *Political Analysis*, 8, 2 (December 1999), 147-165.
2. Anderson, M.C., Banker, R.D., and Ravindran, S. Value implications of investments in information technology. *Management Science*, 52, 9 (September 2006), 1359-1376.
3. Ang, S., and Straub, D.W. Production and transaction economics and is outsourcing: A study of the U.S. banking industry. *MIS Quarterly*, 22, 4 (December 1998), 535-552.
4. Aral, S., Brynjolfsson, E., and Wu, D. Which came first, IT or productivity? The virtuous cycle of investment and use in enterprise systems. In W.D. Haseman (ed.), *Proceedings of the 17th International Conference on Information Systems*, Milwaukee, WI, December 2006.
5. Bakos, J.Y. Reducing buyer search costs: Implications for electronic marketplaces. *Management Science*, 43, 12 (December 1997), 1676-1692.
6. Banker, R. A big deal under the radar. *BusinessWeek Online*, October 9, 2005. Available at www.businessweek.com/magazine/content/05_41/b3954036.htm.
7. Banker, R., and Kauffman, R. Strategic contributions of information technology: An empirical study of ATM networks. In J.I. DeGross and M.H. Olson (eds.), *Proceedings of the 9th International Conference on Information Systems,* Minneapolis, MN, December 1988.
8. Bayus, B.L., and Mason, C.H. An empirical study of innate consumer innovativeness, personal characteristics, and new-product adoption behavior. *Journal of the Academy of Marketing Science*, 31, 1 (January 2003), 61-73.
9. Belsley, D.A., Kuh, E., and Welsch, R.E. *Diagnostics: Identifying Influential Data and Sources of Collinearity*. New York, NY: Wiley-Interscience, 2004.
10. Benaroch, M., and Kauffman, R.J. Justifying electronic banking network expansion using real options

analysis. *MIS Quarterly*, 24, 2 (June 2000), 197-225.
11. Berger, A.N. The economic effects of technological progress: Evidence from the banking industry. *Journal of Money, Credit, and Banking*, 35, 2 (March 2003), 141-176.
12. Besanko, D., Gupta, S., and Jain, D. Logit demand estimation under competitive pricing behavior: An equilibrium framework. *Management Science*, 44, 11 (November 1998), 1533-1547.
13. Bourgeois, L.J. Strategy and environment: A conceptual integration. *Academy of Management Review*, 5, 1 (January 1980), 25-39.
14. Brynjolfsson, E., Hitt, L., and Yang, S. Intangible assets: How the interaction of computers and organizational structure affects stock market valuations. *Brookings Papers on Economic Activity: Macroeconomics*, 1, 1 (March 2002), 139-199.
15. Buser, S.A., Chen, A.H., and Kane, E.J. Federal deposit insurance, regulatory policy, and optimal bank capital. *Journal of Finance*, 36, 1 (March 1981), 51-60.
16. Carr, N.G. IT doesn't matter. *Harvard Business Review*, 81, 5 (May 2003), 41-49.
17. Clemons, E.K. MAC: Philadelphia National Bank's strategic venture in shared ATM networks. *Journal of Management Information Systems*, 7, 1 (Spring 1990), 5-25.
18. Clemons, E.K. An empirical investigation of third-party seller rating systems in e-commerce: The case of BuySafe. *Journal of Management Information Systems*, 25, 2 (Fall 2007), 43-71.
19. Clemons, E.K., and Kimbrough, S.O. Information systems, telecommunications, and their effects on industrial organization. In C. Bullen and E.A. Stohr (eds.), *Proceedings of the 7th International Conference on Information Systems*, San Diego, CA, December 1986.
20. Clemons, E.K., and McFarlan, F.W. Telecom: Hook up or lose out. *Harvard Business Review*, 64, 4 (July-August 1986), 91-97.
21. Clemons, E.K., Reddi, S.P., and Row, M.C. The impact of IT on the organization of economic activity: The "move to the middle" hypothesis. *Journal of Management Information Systems*, 10, 2 (Fall 1993), 9-35.
22. Clemons, E.K., and Row, M.C. Sustaining IT advantage: The role of structural differences. *MIS Quarterly*, 15, 3 (September 1991), 275-292.
23. Clemons, E.K., and Weber, B.W. Strategic information technology investments: Guidelines for decision making. *Journal of Management Information Systems*, 7, 2 (Fall 1990), 9-28.
24. Corrocher, N. Internet adoption in Italian banks: An empirical investigation. *Research Policy*, 35, 4 (May 2006), 533-544.
25. Dandapani, K., Karels, G.V., and Lawrence, E.R. Internet banking services and credit union performance. *Managerial Finance*, 34, 6 (June 2008), 437-446.
26. Daniel, E. Provision of electronic banking in the U.K. and the Republic of Ireland. *International Journal of Bank Marketing*, 17, 2 (1999), 72-83.
27. Davamanirajan, P., Kauffman, R.J., Kriebel, C.H., and Mukhopadhyay, T. Systems design, process performance, and economic outcomes in international banking. *Journal of Management Information Systems*, 23, 2 (Fall 2006), 67-92.
28. Dedrick, J., Gurbaxani, V., and Kraemer, K.L. Information technology and economic performance: A critical review of the empirical evidence. *ACM Computing Surveys*, 35, 1 (March 2003), 1-28.
29. Dehning, B., and Stratopoulos, T. Determinants of a sustainable competitive advantage due to an IT-enabled strategy. *Journal of Strategic Information Systems*, 12, 1 (March 2003), 7-28.
30. DeYoung, R. The performance of internet-based business models: Evidence from the banking industry. *Journal of Business*, 78, 3 (May 2005), 893-948.
31. Drake, L., Hall, M.J.B., and Simper, R. The impact of macroeconomic and regulatory factors on bank efficiency: A non-parametric analysis of Hong Kong's financial services sector. *Journal of Banking and Finance*, 30, 5 (May 2006), 1443-1466.
32. Duliba, K., Kauffman, R.J., and Lucas, H.C. Appropriation of value from airline computer reservation systems. *Organization Science*, 12, 6 (November-December 2001), 702-768.
33. Flannery, M.J., and Sorescu, S.M. Evidence of bank market discipline in subordinated debenture yields: 1983-1991. *Journal of Finance*, 51, 4 (September 1996), 1347-1377.

34. Furst, K., Lang, W., and Nolle, D. Internet banking: Developments and prospects. Working paper 2000-9, Office of the Comptroller of the Currency, Washington, DC, 2000.
35. Furst, K., Lang, W., and Nolle, D. Internet banking in the United States: Landscape, prospects, and industry implications. *Journal of Financial Transformation*, 2 (July 2001), 45-52.
36. Furst, K., Lang, W., and Nolle, D. Internet banking. *Journal of Financial Services Research*, 22, 1 (August-October 2002), 95-117.
37. Greene, W.H. *Econometric Analysis*, 5th ed. Upper Saddle River, NJ: Pearson, 2003.
38. Han, K., Kauffman, R.J., and Nault, B.R. Information exploitation and interorganizational systems ownership. *Journal of Management Information Systems*, 21, 2 (Fall 2004), 109-135.
39. Heckman, J.J. Dummy endogenous variables in a simultaneous equation system. *Econometrica*, 46, 4 (July 1978), 931-959.
40. Lee, L.F., Maddala, G.S., and Trost, R.P. Asymptotic covariance matrices of two-stage probit and tobit methods for simultaneous equation models with selectivity. *Econometrica*, 48, 2 (March 1980), 491-503.
41. Maddala, G.S. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge, UK: Cambridge University Press, 1986.
42. Malone, T., Yates, J., and Benjamin, R. Electronic markets and electronic hierarchies. *Communications of the ACM*, 30, 6 (June 1987), 484-497.
43. Melville, N., Kraemer, K., and Gurbaxani, V. Information technology and organizational performance: An integrative model of it business value. *MIS Quarterly*, 28, 2 (June 2004), 283-322.
44. Pennathur, A.K. Clicks and bricks: E-risk management for banks in the age of the Internet. *Journal of Banking and Finance*, 25, 11 (November 2001), 2103-2123.
45. Piccoli, G., and Ives, B. IT-dependent strategic initiatives and sustained competitive advantage: A review and synthesis of the literature. *MIS Quarterly*, 29, 4 (December 2005), 747-776.
46. Porter, M.E. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York, NY: Free Press, 1980.
47. Quan, J., Hu, Q., and Wang, X.N. It is not for everyone in China. *Communications of the ACM*, 48, 4 (April 2005), 69-72.
48. Rivers, D., and Vuong, Q.H. Limited information estimators and exogeneity tests for simultaneous probit models. *Journal of Econometrics*, 39, 3 (November 1988), 347-366.
49. Roach, S. Services under siege: The restructuring imperative. *Harvard Business Review*, 69, 5 (September-October 1991), 82-91.
50. Rose, J., and Savage, D. Bank holding company *de novo* entry, bank performance, and holding company size. *Quarterly Review of Economics and Finance*, 23, 4 (Autumn 1983), 54-62.
51. Sambamurthy, V., Bharadwaj, A., and Grover, V. Shaping agility through digital options: Reconceptualizing the role of IT in contemporary firms. *MIS Quarterly*, 27, 2 (June 2003), 237-263.
52. Seidmann, A. Personal communication on the use of proxy variables. January 9, 2013.
53. Stiglitz, J.E. Imperfect information in the product market. In R. Schmalensee and R. Willig (eds.), *Handbook of Industrial Organization*, Amsterdam, Netherlands: Elsevier, 1989, 769-847.
54. Theilman, W. Commercial bank liability management and monetary control. *Journal of Financial and Quantitative Analysis*, 5, 3 (September 1970), 329-339.
55. Triplett, J.E., and Bosworth, B.P. *Productivity in the U.S. Services Sector: New Sources of Economic Growth*. Washington, DC: The Brookings Institution, 2004.
56. Tustin, A. *The Mechanism of Economic Systems*. London, UK: Heinemann, 1957.
57. Weill, P. The relationship between investment in information technology and firm performance: A study of the valve manufacturing sector. *Information Systems Research*, 3, 4 (May 1992), 307-333.
58. Wernerfelt, B. A resource-based view of the firm. *Strategic Management Journal*, 5, 2 (April-June 1984), 171-180.
59. Williamson, O.E. *Markets and Hierarchies: Analysis and Antitrust Implications*. New York, NY: Free Press, 1975.
60. Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data*. Boston, MA: MIT Press,

2001.

APPENDIX A. TECHNICAL APPENDIX

2SCML estimation. We compute the *two-stage conditional maximum likelihood* (2SCML) for each of the systems of Equations 1a, 1b and 2 using the following procedure based on Rivers and Vuong [48]. First, we obtained the estimators of $\hat{\Psi}$ and $\hat{\Sigma}_{vv}$ by maximizing the marginal log-likelihood of Y_i for Ψ and Σ_{vv}: $L_n^g(\Psi,\Sigma_{vv}) = \sum_{i=1}^{n} \log g(Y_i \mid X_i;\Psi,\Sigma_{vv})$. Next, we maximized the conditional log likelihood of y_i setting $\Psi = \hat{\Psi}$, for the remaining parameters: $L_n^f(\phi,\beta,\eta,\hat{\Psi}) = \sum_{i=1}^{n} \log f(y_i \mid Y_i, X_i;\phi,\beta,\eta,\hat{\Psi})$, where:

- Σ_{vv} is the covariance matrix of the residuals for the second equation with the non-discrete dependent variable in each of the system of equations;
- Ψ represents the parameters of the second equation in each of the systems of equations;
- Y_i is the non-discrete dependent variable of the second equation in each system;
- y_i is the discrete dependent variable for the Internet;
- X_i represents all exogenous variables for the first equation with the discrete dependent variable in each system of equations;
- ϕ represents the coefficients of *lnTransCosts* and *lnDeposits* in the FSSN System, and the coefficients of *lnRevenue* and *lnNetIncome* in the IT-Performance System;
- β is the vector of parameters in the probit equation of the simultaneous system;
- n is the size of the sample;
- v represents the residuals for the second equation in each system of equations (i.e., the equation with the non-discrete dependent variable); and,
- η represents the coefficient of v in the second-stage probit regression.

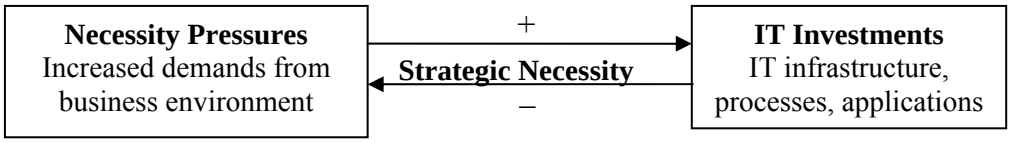
Testing of simultaneity. To test for simultaneity, we computed the likelihood ratio test statistic, *LR*, for the FSSN System (*lnTransCosts* and *lnDeposits*) using the specification $LR = -2(\ln \hat{L}_R - \ln \hat{L}_U)$. This is the log-likelihood function of the probit estimation (the restricted specification, *R*) and $\hat{L}_U$ is the log-likelihood function of the 2SCML estimation (the unrestricted specification, *U*). The *LR* statistic has a χ^2 distribution with degrees of freedom equal to the number of endogenous variables, which is one here. For both equations in the FSSN System, our tests suggest the presence of simultaneity with $p < 0.01$.

To test for simultaneity in the IT-Performance System (for *lnRevenue* and *lnNetIncome*), we adapted the Hausman test statistic: $H = (\hat{\theta}_{2SPLS} - \hat{\theta}_{OLS})'(\hat{V}_{2SPLS} - \hat{V}_{OLS})^{-1}(\hat{\theta}_{2SPLS} - \hat{\theta}_{OLS})$. This modified test is used when simultaneity is suspected and the dependent variable is not discrete [12]. The vector $\hat{\theta}$ represents the estimators from each estimation method and $\hat{V}$ represents the covariance matrix of the estimators. The test statistic *H* follows a χ^2 distribution with *k* degrees of freedom, where *k* is the number of dimensions in the vector $\hat{\theta}$. Under the null hypothesis when simultaneity does not exist, ordinary least squares regression provides consistent estimates. For both proxies of performance, we show the presence of simultaneity with $p < 0.001$. (See Table A1.)

INSERT TABLE A1 ABOUT HERE

FIGURES AND TABLES

Figure 1. Strategic Necessity as a Simultaneous Relationship



Note: Instances of IT investments as a result of strategic necessity include telecommunication networks [20], bank ATMs [7, 17], financial risk management systems [38], Internet transaction indemnification intermediaries [18], and computerized airline reservation systems (CRS) [32]. To illustrate the case of CRS, the Airline Deregulation Act of 1978 increased competition within the industry. Since the change, airlines and travel agents have seen a greater need to have real-time access to airline schedules and fares. During the same time, various carriers were questioning the rising costs of manual operations in ticketing offices and were looking for cost effective alternatives. By the 1980s, most major airlines understood the importance of CRS and began adopting it. All these factors have transformed CRS into a strategic necessity for the airlines.

Figure 2. Relationship between Firm Strategy, Strategic Necessity, IT and Performance

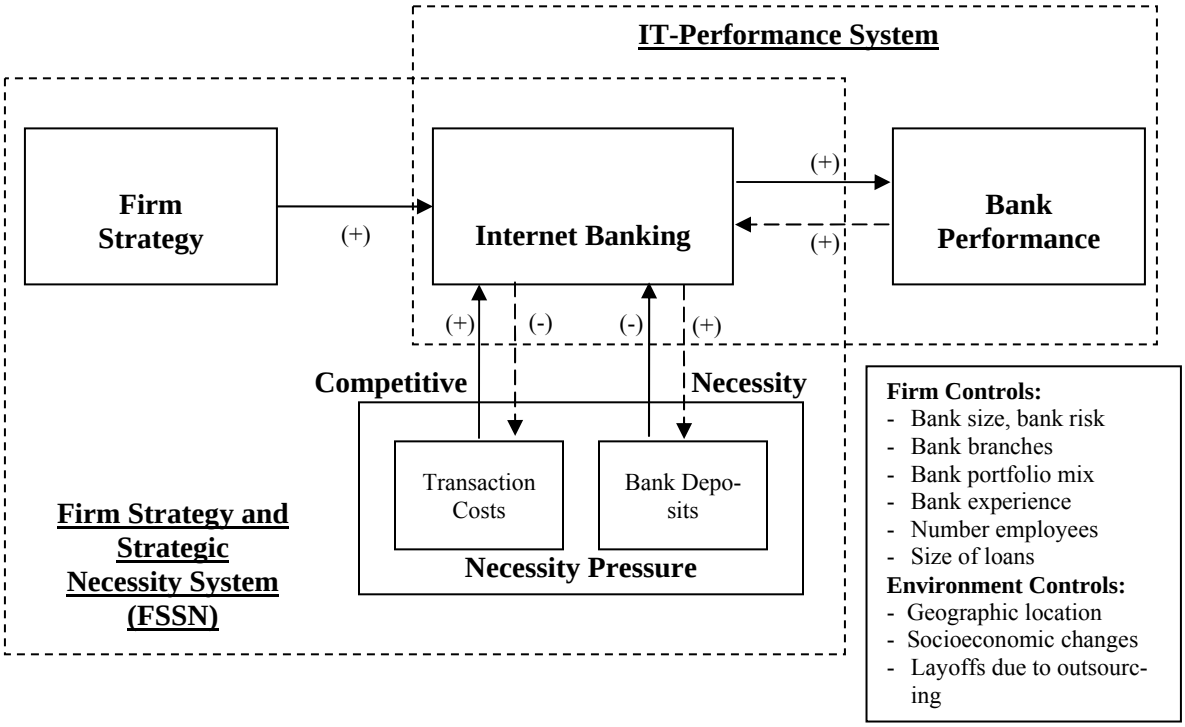
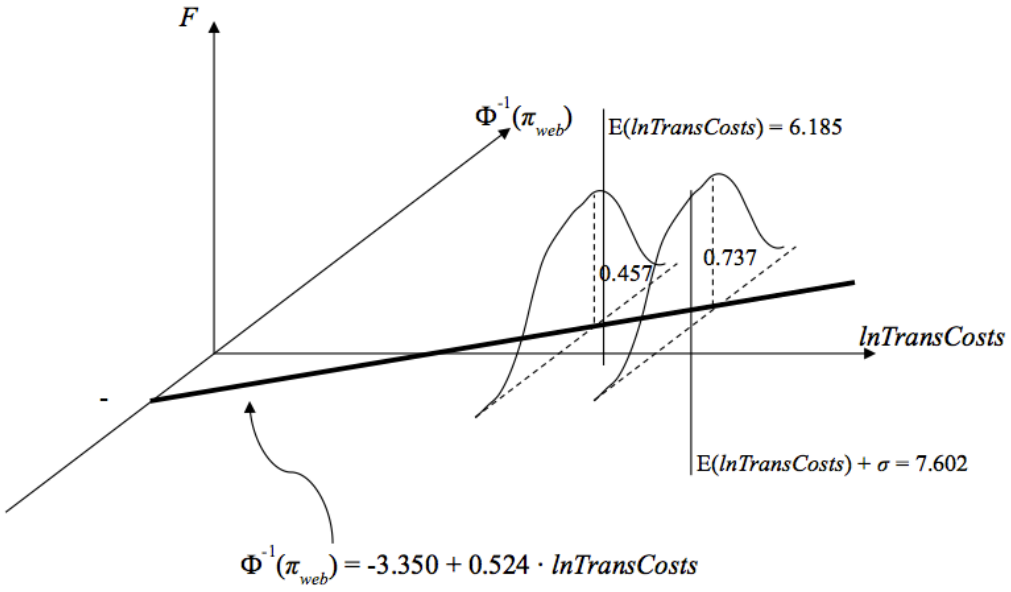
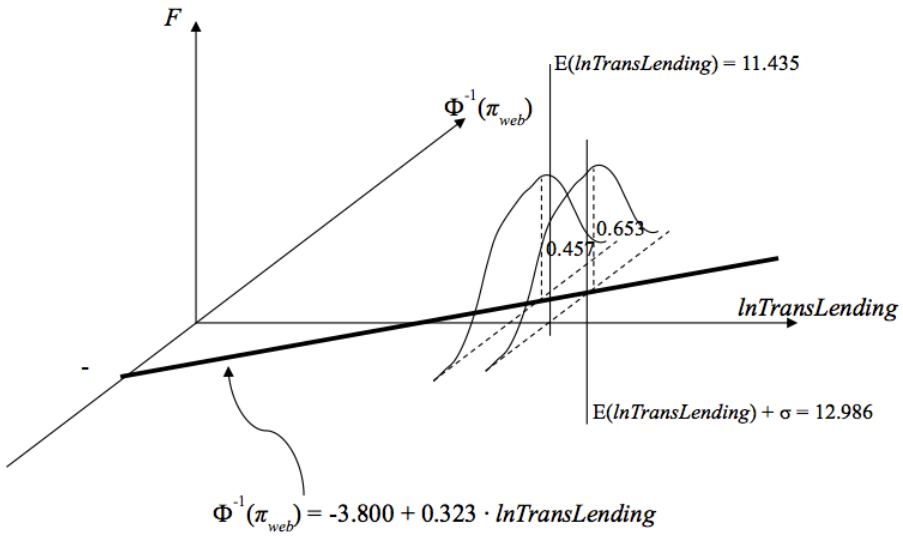


Figure 3. The Conditional Probability Distribution of Strategic Necessity



Note: The shaded region, π_{web}, represents the probability of Internet banking implementation of a bank. The density function F is depicted with σ representing one standard deviation from the mean and Φ^{-1} representing the inverse of a standard normal probability distribution function. For the curve on the left, we observe that $\pi_{web} = \Phi$ (-3.350 + 0.524 · 6.185) = 0.457.

Figure 4. Conditional Probability Distribution of Firm Strategy



Note: The figure should be interpreted as we discussed for its companion figure above, only for firm strategy.

Figure 5a. Firm Strategy Impact on Internet Banking Adoption

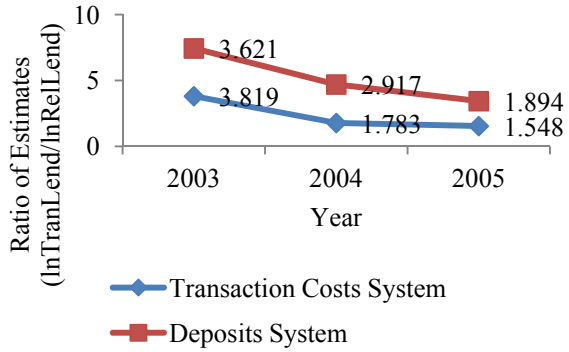
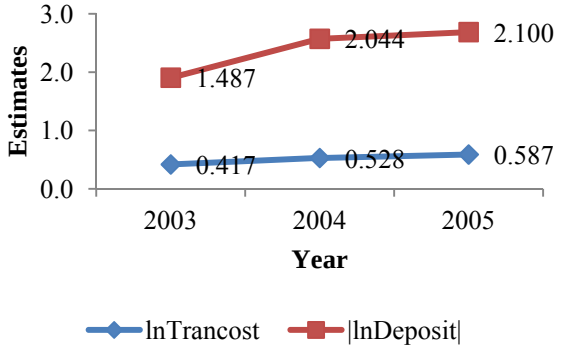


Figure 5b. Strategic Necessity Impact on Internet Banking Adoption



Note: The figures show the changes in magnitude of the coefficients. In Figure 5a, we see the importance of loan distribution strategy in affecting Internet banking investment declined from 2003 to 2005. In Figure 5b, we see the pressure to decrease transaction costs and increase deposits became more important from 2003 to 2005 for Internet banking investment decisions.

Figure 6a. Internet Banking Impacts on Deposits (via *Web* Variable)

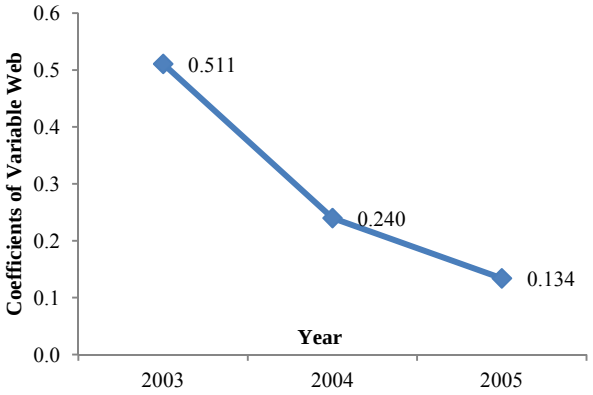
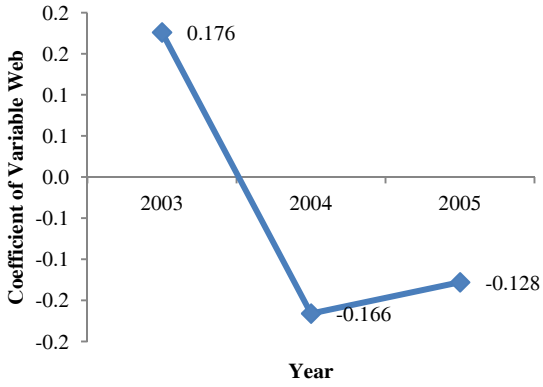


Figure 6b. Internet Banking Impacts on Transaction Costs (via *Web* Variable)



Note: Coefficients in Figure 6a show the increased impact of Internet banking on attracting bank deposits from 2003 to 2005. In Figure 6b, they show the impact of Internet banking on banking transaction costs. The diminishing values in these figures suggest that banks were able to reduce transaction costs through Internet banking investments over the course of our study period.

Table 1. Descriptive Statistics of the Variables Used in Empirical Model

	2003			2004			2005		
VARIABLE	MEAN	MEDIAN	STDDEV	MEAN	MEDIAN	STDDEV	MEAN	MEDIAN	STDDEV
lnRelLending	9.59	9.63	1.60	9.57	9.62	1.61	9.63	9.68	1.63
lnTransLending	11.46	11.38	1.54	11.44	11.36	1.55	11.49	11.43	1.586
lnAsset	11.71	11.56	1.35	11.78	11.63	1.38	11.84	11.69	1.39
#Branches	9.44	3.00	74.81	10.14	3.00	85.15	10.48	3.00	98.69
lnDeposits	11.47	11.37	1.37	11.53	11.43	1.40	11.58	11.49	1.43
%NCLoans	1.04	0.57	2.01	0.87	0.45	1.66	0.81	0.42	1.85
lnTransCosts	6.13	6.03	1.42	6.19	6.09	1.42	6.23	6.14	1.44
ln#Employees	3.67	3.53	1.25	3.69	3.56	1.260	3.71	3.58	1.26
lnNetIncome	7.04	6.97	1.59	7.14	7.07	1.60	7.24	7.17	1.61
%RealEstate	0.76	0.45	1.09	0.66	0.37	0.95	0.61	7.17	0.89
lnRevenue	7.09	7.01	1.59	7.16	7.09	1.59	7.25	7.17	1.61
lnLoans	11.32	11.22	1.46	11.30	11.20	1.47	11.36	11.27	1.51
#Layoffs	757.65	0.00	2,084.49	689.23	0.00	1,689.82	495.44	0.00	1,354.89
Web	0.54	1.00	0.50	0.61	1.00	0.49	0.68	1.00	0.47

Note: Additional details of the variables are provided in Section 5.2.

Table 2. Two-Stage Probit Least Squares for Simultaneous Equations with Fixed Effects

	FIRM STRATEGY AND STRATEGIC NECESSITY SYSTEM				IT-PERFORMANCE SYSTEM			
DEP. VAR	**TRANSACTION COSTS**		**DEPOSITS**		**REVENUE**		**NET OPER. INCOME**	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	0.278*	0.113	1.114***	0.073	-5.81***	0.191	-5.88***	0.196
Web	-0.076***	0.019	0.257***	0.013	0.135***	0.029	0.165***	0.029
lnAssets	0.061***	0.011	0.900***	0.007	1.043***	0.018	1.040***	0.019
lnLoans	0.205***	0.013	-0.036***	0.008	0.094***	0.022	0.090***	0.022
ln#Employees	0.843***	0.012	-0.087***	0.008	-0.171***	0.019	-0.195***	0.020
%RealEstate	-0.005	0.004	0.018***	0.003	-0.080***	0.007	-0.083***	0.007
Age	-0.001***	8.5E-5	0.001***	5.5E-05	0.002***	1.2E-04	0.002***	1.0E-04
#Branches	-5.6E-05	3.7E-5	2E-04***	2.4E-05	-4.9E-05	5.8E-05	9.0E-06	5.9E-05
%NCLoans	0.006**	0.002	0.014***	0.002	0.018***	0.004	0.019***	0.004
#Layoffs	-4.3E-06	7.4E-06	-7.9E-06	4.7E-06	-4.0E-05**	1.3E-05	-4.0E-05**	1.3E-05
Year2003	-0.118***	0.012	0.143***	0.008	0.083***	0.018	0.073**	0.019
Year2004	-0.029***	0.008	0.070***	0.005	0.025	0.012	0.018	0.013
State	State dummies are not reported due to lack of space and our emphasis on the main effects.							
Adjusted-R^2	92.0%		96.3%		83.9%		82.9%	
DEP. VAR.	**WEB BANKING**		**WEB BANKING**		**WEB BANKING**		**WEB BANKING**	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	-5.496***	0.273	-7.934***	0.264	-11.079***	0.648	-11.185***	0.643
lnRevenue					0.429***	0.098		
lnNetIncome							0.438***	0.094
lnTransCosts	0.524***	0.032						
lnDeposits			-1.431***	0.368				
lnRelLending	0.156***	0.009	0.202***	0.013	0.196***	0.010	0.200***	0.011
lnTransLending	0.323***	0.021	0.593***	0.039	0.534***	0.022	0.536***	0.022
lnAssets	-0.238***	0.032	1.321***	0.317	0.523***	0.104	0.530***	0.099
#Branches	-0.001***	2.0E-04	-0.001***	2.6E-04	-0.001***	2.8E-04	-0.001***	2.7E-04
Year2003	-0.495***	0.023	-0.491***	0.024	-0.494***	0.024	-0.51***	0.024
Year2004	-0.222***	0.023	-0.200***	0.023	-0.227***	0.024	-0.232***	0.024
State	State dummies are not reported due to lack of space and our emphasis on the main effects.							
Pseudo-R^2	26.5%		25.8%		27.3%		27.5%	

Notes: Washington, DC is the base case for the *State* dummy variables. A fixed-effects estimation was run with *Year2005* as the base case. $N = 23{,}250$ observations. Signif.: *** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$.

Table 3. Two-Stage Probit Least Squares Estimation for Individual Years, 2003 to 2005

	Transaction Costs System			Deposits System		
Dep. Var.	*lnTransCosts*			*lnDeposit*		
	2003 Coef. (SE)	**2004 Coef. (SE)**	**2005 Coef. (SE)**	**2003 Coef. (SE)**	**2004 Coef. (SE)**	**2005 Coef. (SE)**
Constant	1.594*** (0.291)	-0.508* (0.215)	0.339* (0.151)	2.771*** (0.185)	1.387*** (0.138)	0.756*** (0.101)
Web	0.176*** (0.048)	-0.166*** (0.032)	-0.128*** (0.027)	0.511*** (0.030)	0.240*** (0.020)	0.134*** (0.018)
lnAssets	0.165*** (0.018)	0.026 (0.020)	-0.035 (0.020)	1.016*** (0.011)	0.875*** (0.013)	0.784*** (0.013)
lnDeposits	-0.011 (0.030)	0.285*** (0.023)	0.291*** (0.019)	-0.274*** (0.020)	-0.009 (0.0150)	0.111*** (0.013)
lnLoans	0.762*** (0.023)	0.861*** (0.020)	0.886*** (0.020)	-0.190*** (0.015)	-0.082*** (0.013)	-0.013 (0.013)
ln#Employees	0.001 (0.006)	-0.023** (0.008)	-0.013 (0.008)	0.006 (0.004)	0.025*** (0.005)	-0.013** (0.005)
Age	-0.001*** (1.5E-04)	-0.002*** (1.5E-04)	-0.001*** (1.4E-4)	0.001*** (9.4E-5)	0.001*** (9.4E-5)	0.001*** (9.4E-5)
#Branches	2.4E-04* (8.9E-05)	-1.7E-04* (6.7E-05)	-5.8E-05 (5.1E-05)	0.001*** (5.7E-05)	2.8E-04*** (4.3E-05)	4.1E-05 (3.4E-05)
%NCLoans	0.017** (0.006)	0.014*** (0.004)	0.003 (0.005)	0.040*** (0.004)	0.007** (0.002)	0.023*** (0.003)
State	State dummies are not reported due to lack of space and our emphasis on the main effects.					
Adjusted-R^2	0.921	0.920	0.919	0.964	0.965	0.961
Dep. Var.	**Web Banking**			**Web Banking**		
Constant	-6.437*** (0.487)	-6.566*** (0.562)	-4.882*** (0.451)	-8.561*** (0.437)	-8.983*** (0.553)	-6.678*** (0.436)
lnTransCosts	0.417*** (0.056)	0.528*** (0.055)	0.587*** (0.054)			
lnDeposits				-1.487** (0.555)	-2.044** (0.727)	-2.100*** (0.394)
lnRelLending	0.116*** (0.019)	0.166*** (0.015)	0.168*** (0.015)	0.177*** (0.020)	0.230*** (0.0240)	0.132*** (0.021)
lnTransLending	0.443*** (0.037)	0.296*** (0.036)	0.260*** (0.036)	0.641*** (0.040)	0.671*** (0.088)	0.250** (0.073)
lnAssets	-0.166** (0.058)	-0.225*** (0.055)	-0.280*** (0.054)	2.028*** (0.359)	1.798** (0.606)	-1.174* (0.462)
#Branches	-0.001*** (3.3E-04)	-0.001*** (3.2E-04)	-0.001* (4.2E-04)	-0.001*** (3.8E-04)	-0.001** (3.9E-04)	0.002 (0.005)
State	State dummies are not reported due to lack of space and our emphasis on the main effects.					
Pseudo-R^2	0.270	0.255	0.250	0.269	0.248	0.239

Notes: Washington, DC is the base case for the *State* dummy variables. $N = 7{,}750$.

Table A1. Results of Likelihood Ratio Tests (2SCML) and Hausman Tests (2SPLS)

System of Equations (Dep. Var.)	Model Comparison (Unrestricted vs. Restricted)	Test Statistic	Conclusion
Strategic Necessity (for *lnTransCosts*)	2SCML vs. Probit	*LR*: 37.45***	Simultaneity exists
Strategic Necessity (for *lnDeposits*)	2SCML vs. Probit	*LR*: 29.24***	Simultaneity exists
IT-Performance (for *lnRevenue*)	2SPLS vs. OLS	*H*: 1.23 E+17***	Simultaneity exists
IT-Performance (for *lnNetIncome*)	2SPLS vs. OLS	*H*: 2.23 E+09***	Simultaneity exists

Note: *LR*: Likelihood ratio test; *H*: Hausman test statistic. Restricted models: Probit, OLS. Unrestricted models: 2SCML, 2SPLS. Signif.: *** = $p < 0.01$.

BRIEF BIOS AND AUTHORS' CONTACT INFORMATION

Kim Huat Goh is an Assistant Professor in the Division of IT and Operations Management in the Nanyang Business School at Nanyang Technological University. He received his Ph.D. in Business Administration with a specialization in Information Systems from the Carlson School of Management, University of Minnesota. His research interests include applying behavioral economic theories to explain consumer behavior in technology-mediated environments, examining the value of IT and IT strategy. His research has appeared in *MIS Quarterly*, *Information Systems Research*, the *Journal of Management Information Systems* and *Electronic Commerce and Research Applications.*

- Nanyang Business School, Nanyang Technological University S3-B2A-34, 50 Nanyang Avenue, Singapore 639798. Email: akhgoh@ntu.edu.sg; telephone: +65-6790-4808.

Robert J. Kauffman is the Lee Kuan Yew Fellow for Research Excellence and a Professor of Information Systems at the School of Information Systems. He also serves as Associate Dean (Research) and Deputy Director of the Living Analytics Research Centre. He recently was a Distinguished Visiting Fellow at the Center for Digital Strategies of the Tuck School of Business, Dartmouth College. His research has appeared in *Information Systems Research*, *Telecommunications Policy*, the *Journal of Management Information Systems*, *MIS Quarterly*, *IBM Research and Development Journal*, *Decision Support Systems*, the *Review of Economics and Statistics*, and *Operations Research Letters*. His research focuses on technology and strategy, the economics of IT, technology in financial services and e-business, managerial decision making, and innovations in research methods.

- School of Information Systems, Singapore Management University**,** 80 Stamford Road, Singapore 178902. Email: rkauffman@smu.edu.sg; telephone: +65-6828-0929.